TUBA:
User Manual

Version 1.9.5
November 2014

Department for Transport

ATKINS

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Great Minster House, 33 Horseferry Road, London, SW1P 4DR

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1. Introduction

1.1 Overview

TUBA (Transport Users Benefit Appraisal) is a computer program developed for Department for Transport (DfT) to undertake an economic appraisal for a multi-modal transport study.

The aim of TUBA is to carry out economic appraisal in accordance with the DfT's Transport Analysis Guidance as set out in Unit A1-1 'Cost-Benefit Analysis' (https://www.gov.uk/government/publications/webtag-tag-unit-a1-1-cost-benefit-analysis-november-2014). This implements elements of the Sugden method. Details of the method, as implemented in TUBA can be found in TAG Unit A1-3 [1] (and, in particular, Appendix A).

TUBA undertakes a matrix-based appraisal with either fixed or variable trip matrices. It takes trip, time, distance and charge matrices from a transport model. These matrices may be disaggregated by vehicle type, purpose, and person type. The user also inputs other costs associated with the do-minimum and do-something schemes. TUBA will then calculate the user benefits in time, fuel vehicle operating costs (VOC), non-fuel VOC and charge; operator and government revenues; and the scheme costs, discounted to the present value year. Values calculated from input model data will be interpolated and extrapolated to cover the full appraisal period as necessary. The output file contains all these results for various degrees of disaggregation and also presents the data in a series of summary tables showing the economic efficiency of the transport system, known as TEE tables. Results are reported as perceived costs and market prices.

TUBA does not calculate benefits that are due to changes in accident costs. Accident benefits may be calculated using the DfT's COBALT (Cost and Benefit to Accidents – Light Touch) software tool[2].

1.2 Contacts

Contacts for support on the application of TUBA are:

- Principles of TUBA:

  Transport Appraisal and Strategic Modelling Division, Department for Transport, Zone 2/25 Great Minster House, 33 Horseferry Road, London, SW1P 4DR.

  E-mail: tasm@dft.gsi.gov.uk

- Running TUBA:

  TUBA Software Support, Atkins Limited, Woodcote Grove, Ashley Road, Epsom, Surrey, KT18 5BW. Tel: 0044 1372-756755

  E-mail: tuba@atkinsglobal.com

[1] https://www.gov.uk/government/publications/webtag-tag-unit-a1-3-user-and-provider-impacts-november-2014

[2] https://www.gov.uk/government/publications/cobalt-software-and-user-manuals

1.3 Structure of the manual

The rest of this manual is laid out as follows:

- Section 2: Information on installing TUBA;
- Section 3: An overview of the operation of TUBA;
- Sections 4 & 5: Detailed information on setting up the scheme and economics files;
- Sections 6: Explanation of TUBA output; and
- Appendices A-F: Format specifications for input and output files.

2. Installation

2.1 Process

The TUBA installation file is supplied on CD, via email or by download from the TUBA website[3]. It has a filename of the form 'Release.zip'. If you receive the software on CD, the installation process should start automatically on inserting the CD into the drive. If this does not happen, or you have received the software through a different medium you will need to run the installation program manually.

From TUBA v1.9.4 onwards, there are two versions of the TUBA software – a 64-bit version only compatible with 64-bit versions of the Windows Operating System (OS) or a 32-bit version compatible with both 32-bit and 64-bit versions of the OS. Either version will produce the same numerical outputs but the 64-bit version will be able to handle larger datasets. Further information is provided in section 3.11.

By default, the files will be stored on the C drive on the computer in the 'Program Files' directory in the sub-directory either called 'DfT\TUBA v1.9.4' (e.g. "C:\Program Files\DfT\TUBA v1.9.4\") for the 32-bit version or DfT\TUBA v1.9.4 64-bit' (e.g. "C:\Program Files (x86)\DfT\TUBA v1.9.4 64-bit\") for the 64-bit version. To uninstall either program, use Add/Remove Programs from the Control Panel.

The standard economics data file, which is consistent with WebTAG: TAG Data Book[4] will be copied to the \economics\ subdirectory.

The standard TUBA test examples will be copied to the 'C:\TUBAdemo' folder.

The TUBA manual (this document), the TUBA guidance note (which provides guidance on producing data for TUBA from a transport model), a description of the demonstration data, a list of frequently asked questions (FAQs) and a guidance note on checking results will be placed in the 'manuals' subdirectory.

The 'papers' subdirectory contains two TUBA-related papers from the 2001 European Transport Conference.

Documentation and papers are in pdf format which can be read using Adobe Acrobat Reader (available free from www.adobe.com/reader).

Demonstration data will be automatically installed into the directory c:\TUBAdemo\.

Approximately 10Mb of disk space is required for the installation.

2.2 System requirements

To run TUBA we recommend the following as a minimum specification;

- Windows XP/Vista/Windows 7/8 32-bit or 64-bit;
- 256Mb RAM (although large problems will benefit from extra RAM); and

[3] https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals

[4] https://www.gov.uk/government/publications/webtag-tag-data-book-november-2014

- 10Mb Hard Disk space (for installation).

The amount of disk space required for storing results will depend on the number of zones in the transport model and the level of disaggregation of the input data.

For TUBA runs with large data sets extra RAM can give significant improvements in run times. For very large data sets, the TUBA 64-bit version should be used – this available as a separate download.

3. Running TUBA

3.1 Overview

TUBA is controlled via two main input files and outputs two files. Data from the transport model, in the form of matrices of trip numbers, distances, times and charges are also required.

The two main input files are:

- Economic parameters file: This contains data such as values of time, VOC coefficients, tax rates and economic growth. It also contains standard categories for mode, vehicle type, trip purpose etc. It is available in the \economics subfolder. Users may edit this file to suit the needs of their study.
- Scheme-specific file: This contains data specific to the scheme being modelled, such as the scheme costs. It is also used to specify the trip and cost matrices generated by the transport model.

Both these input files can be created and edited via the user interface. Alternatively a text editor program can be used.

A standard output file (.out) is produced containing the following information:

- List of errors and warnings during the program execution
- Summary of input information
- Tabulations of scheme costs
- Tabulations of user benefits, government and operator revenues by various categories
- Summary information in TEE (Economic Efficiency of the Transport System) format

A second output file (.tbn) presents time benefits broken down by the change in travel time and trip numbers for each OD.

In addition there is an option to produce a detailed results file in binary format containing fully disaggregate results which can be interrogated via the user interface.

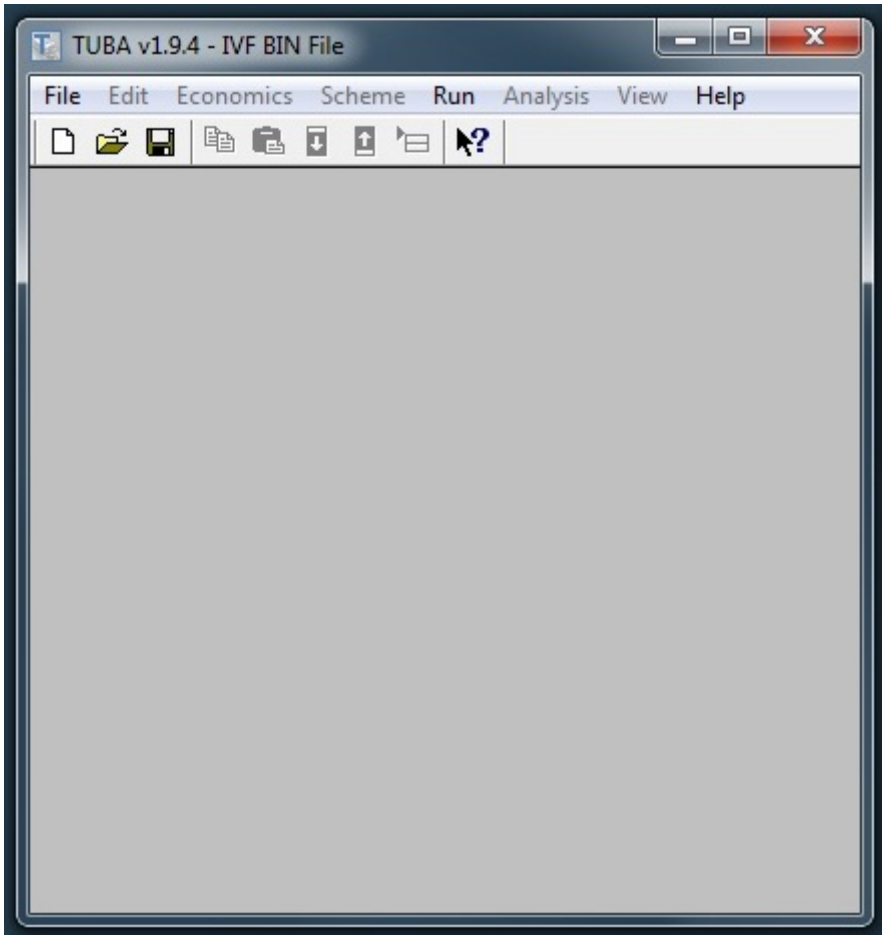
The names of the input and output files are defined via batch files with a .BAT extension. The contents of these batch files are edited in the user interface via the Run->Settings menu (see Section 3.5).

3.2 Starting TUBA

The TUBA installation process automatically creates a shortcut to TUBA on the Windows desktop. Alternatively, TUBA can be started from the Start menu, Start->Programs->DfT->TUBA v1.9.5 (or TUBA v1.9.5 64-bit).

On starting TUBA the user is presented with the screen shown in Figure 3.1 below:

Figure 3.1: Example of the Initial TUBA screen



This is a standard Windows interface with a menu bar and toolbar buttons for the most common operations. Placing the cursor over a button will display an explanation of its operation.

3.3 File menu

Under File are the usual options found with Windows software:

- New
- Open
- Close
- Save
- Save As
- Exit

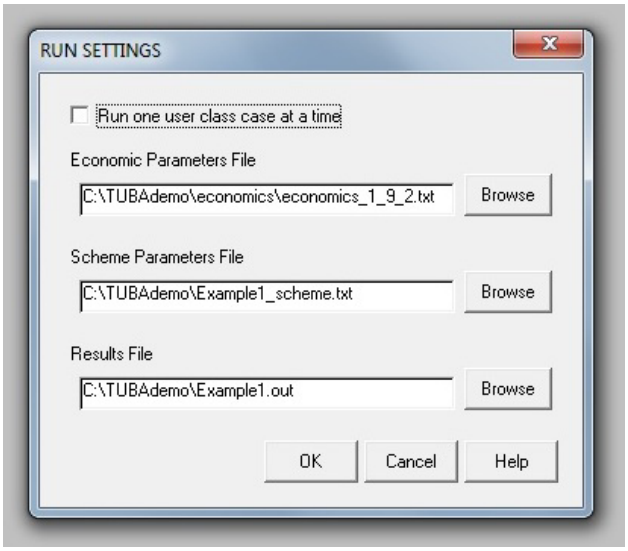
plus a most recently used file list. Save and Save As apply separately to each of the batch, scheme and economics files.

This menu is used to create, open and save TUBA batch files and to exit the program.

3.3.1 Run Settings Template

Selecting File->New brings up the following Run Settings template (Figure 3.2):

Figure 3.2: Example Run Settings template



This is used to define the input and output file names, which may be typed directly or selected using the standard Windows 'Browse' dialogue. By default the standard economics file supplied with the software will be defined in the 'Economic Parameters File' box.

The economics and/or scheme file names can be left blank if either is to be created from scratch. After editing these they should be saved using the File->Save As options. A results file must be specified before TUBA can carry out its calculations.

Once these filenames have been defined and after clicking OK they can be saved to a batch file using File->Save Batch or File->Save Batch As. Saved batch files can be re-opened and edited.

File->Save All saves the batch file and any changes to the scheme or economics files. The batch, scheme or economics files can be saved under different file names using the File->Save As command.

When opening a batch file, or changing the scheme or economics file, the files are checked for errors. A message will be displayed if there are any problems. Details can be viewed from the View >Warnings menu.

3.3.2 Running One User Class at a Time

The option 'Run one user class at a time' can be used to reduce memory requirements and should be selected in cases where there is insufficient RAM and

Windows is using a lot of virtual memory. In cases where there is sufficient RAM using this option will slow down the software slightly. **It is now the recommended setting for modern PCs.**

The Run Settings template is also accessed from the Run->Run Settings menu.

3.4 Data entry and editing

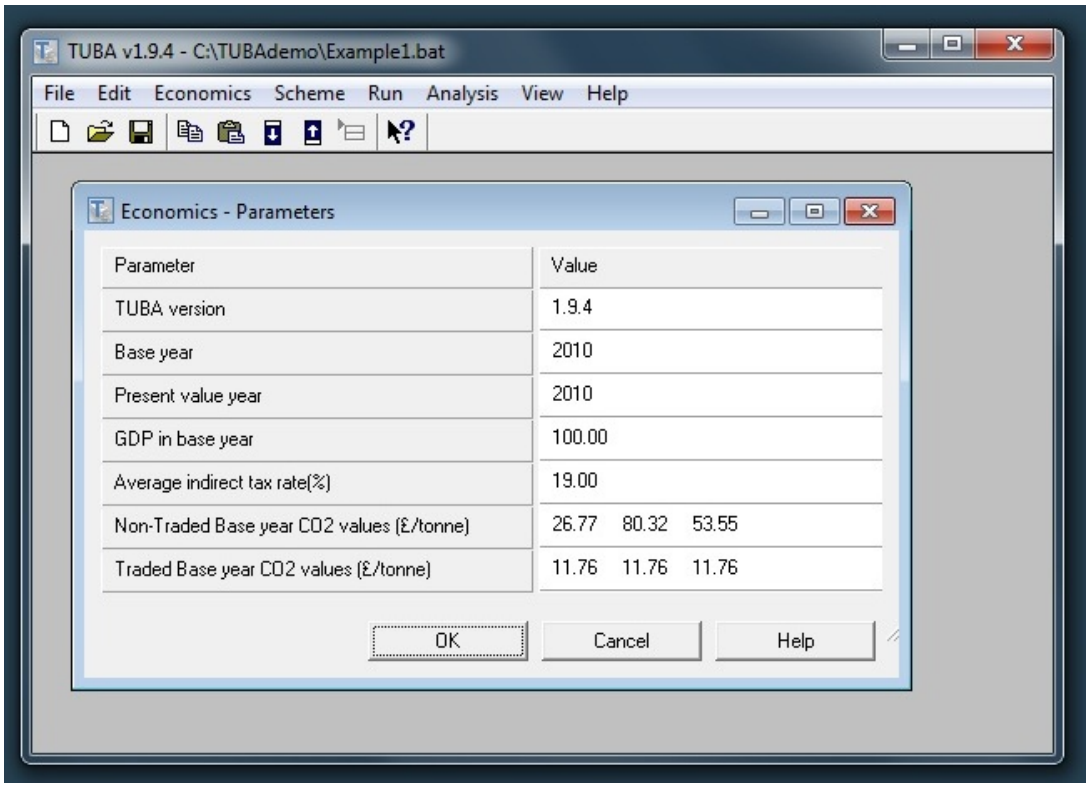
Economics data can be edited by selecting 'Economics' on the menu bar and then selecting an appropriate sub menu. A full description of the different types of economic data can be found in section 3.9. Similarly, scheme data is edited by selecting 'Scheme' from the menu bar. Full details are given in section 5.

All data input screens have a similar format. The example in Figure 3.3 shows the value of time input table. The template is like a simple spreadsheet, with the user being able to edit the white areas. Clicking the Help button will bring up information to aid completion of the current table.

Navigation between cells is via the Tab and Shift-Tab keys to move right and left and the up and down cursor keys to move up and down. In the larger tables a scroll bar is also used.

Data in individual cells can be copied and pasted via the menu brought up by right-clicking the mouse when the cursor is in the appropriate cell. Alternatively the whole table can be copied or pasted using the copy and paste buttons on the toolbar. This allows transfer of data to or from a spreadsheet.

Figure 3.3: Example data input screen



3.5 Run

3.5.1 Standard Options

The Run menu has three sub-menus:

- Run settings: to select or change the name of the input and output files
- Run now: to carry out the TUBA calculations (after input and output file names have been defined). On completion a summary of errors and warnings will be displayed. Any errors encountered will cause the program to stop and will need to be rectified. Warnings and serious warnings represent possible anomalies in the input data and warrant further investigation by the user.
- Run batch: to open a TUBA .GRP file containing a list of TUBA runs. This enables a sequence of TUBA runs to be carried out without user intervention. The 'Run Batch' option is only available if a TUBA file is not already open in the GUI. The .GRP file contains a list of individual TUBA .BAT files, e.g.:

  C:\TUBADEMO\EXAMPLE1.bat
  C:\TUBADEMO\EXAMPLE2.bat
  C:\TUBADEMO\EXAMPLE3.bat
  C:\TUBADEMO\EXAMPLE4.bat

3.5.2 Advanced Run Options

There are also further options for more advanced users to run TUBA outside the standard Graphical User Interface (GUI) using existing batch files and command prompts:

- *Running TUBA directly* – the TUBA Engine (i.e. TUBA_ENG.EXE) may be run directly from a command prompt via the standard batch file, provided the location of TUBA executables is provided in the path. In other words, using Example1.bat referenced above (with TUBA installed in the default directory described in section 2.1):

  - the standard Example1.bat

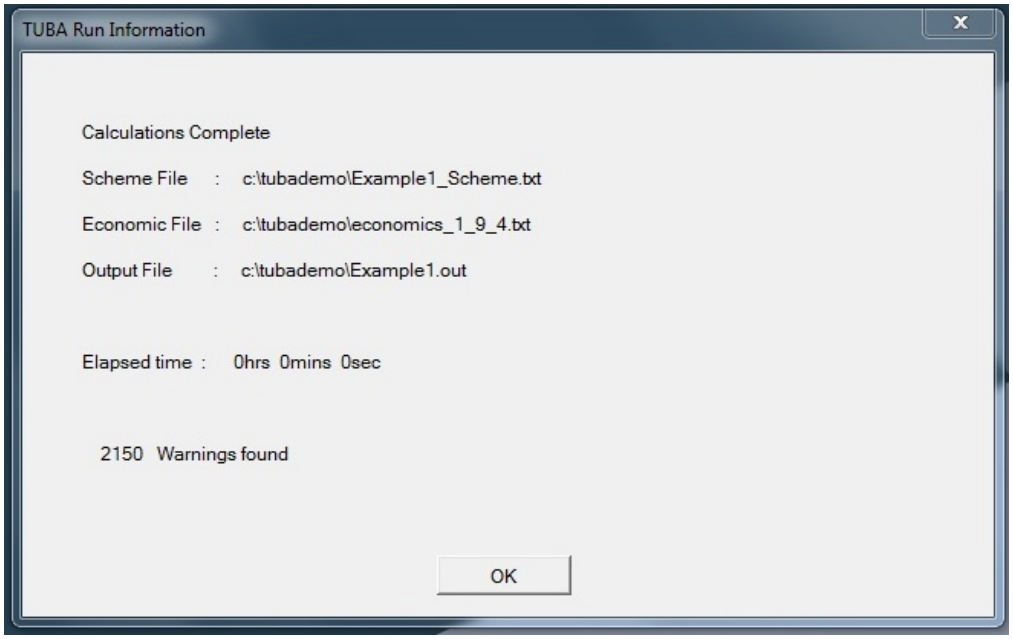
```
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out"
```

  - is modified to

```
set path="C:\Program Files\DfT\TUBA v1.9.5";%path%
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out"
```

  Once the TUBA has completed, the standard confirmation screen will appear and showing a summary including the input and output filenames, the number of warnings and the total runtime. The user will need to click the 'Continue' button to end the run as usual (see Figure 3.4 below).

Figure 3.4: TUBA Run Confirmation Screen



- *Running TUBA with one user class at a time* – the TUBA GUI already provides the option to run TUBA using one user class at a time (see section 3.3.2. above). The same option may be configured via the batch file by adding a "1" marker at the end of the TUBA_ENG parameter line as shown below:

  - the standard Example1.bat

```
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out"
```

  - is modified to

```
set path="C:\Program Files\DfT\TUBA v1.9.5";%path%
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out" 1
```

  Again once the TUBA has completed, the standard confirmation screen will appear and the user will need to click the 'OK' button to continue.

- *Removing the TUBA confirmation screen* –the TUBA GUI also enables several runs to be grouped together (see section 3.5.1, third bullet point) with the TUBA confirmation screen and the information written to a log file instead. The same option may be configured via the batch file by adding the path and name of the log file at the end of the TUBA_ENG parameter line as shown below:

  - the standard Example1.bat

```
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out"
```

  - is modified to

```
set path="C:\Program Files\DfT\TUBA v1.9.5";%path%
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out"
"C:\TUBAdemo\Example1.log"
```

This option may also be combined with the "One User Class at a Time" as shown below:

```
set path="C:\Program Files\DfT\TUBA v1.9.5";%path%
tuba_eng "C:\TUBAdemo\Example1_scheme.txt"
"C:\TUBAdemo\economics\economics_1_9_5.txt" "C:\TUBAdemo\Example1.out" 1
"C:\TUBAdemo\Example1.log"
```

The log file may be re-used as the summaries from the separate runs are appended to the end of the file if it already exists (otherwise it will be created).

3.6 Analysis

The Analysis menu gives the user the opportunity to interrogate the fully disaggregate results that are stored in the binary file (provided the option for detailed results was set in the scheme file). This facility selects the data that matches the criteria set by the user and outputs them to a CSV format file. This can be opened in any spreadsheet package for further analysis or for plotting graphs.

More details are given in section 6.4.

3.7 View

Using the view menu it is possible to open the input and output files with the default Windows text editor. *This feature should not be used to edit the input files* - either edit via the user interface or close down TUBA and use your preferred text editor.

3.8 Help feature

The TUBA help system can be accessed in two ways. From the Help menu the entire help file is opened and can be searched for keywords. Alternatively clicking the Help button in a template will bring up context-sensitive help, giving guidance on that particular data table

3.9 Managing Memory

3.9.1 Memory Requirements

To minimise the total memory required whilst also providing sufficiently flexibility for TUBA to assess a wide range of different scheme configurations, TUBA uses dynamic memory allocation to manage its requirements.

The amount of memory needed varies considerably, particularly with very large models, with the total memory required increasing and decreasing depending on the calculations being undertaken. Following the introduction non-traded and traded carbon-based appraisal in TUBA v1.9, the total memory required has grown and this has increased the likelihood that the TUBA will 'crash' due to insufficient memory available.

As an example, the memory requirement for a very large model with three forecast years, seven user classes, three time periods and around 1400 zones (with 61 sectors) will be more than 10Gb RAM. Running with the 'One User Class at a time' option will reduce that to a more manageable peak demand of around 1.25Gb RAM (which is approaching the practical limits with the 32-bit software).

From TUBA v1.9.1 onwards, additional memory checks were introduced to detect the potential memory problem at the start of the TUBA run. These checks have been extended to also be undertaken whilst the software is running with TUBA v1.9.2 (or later).

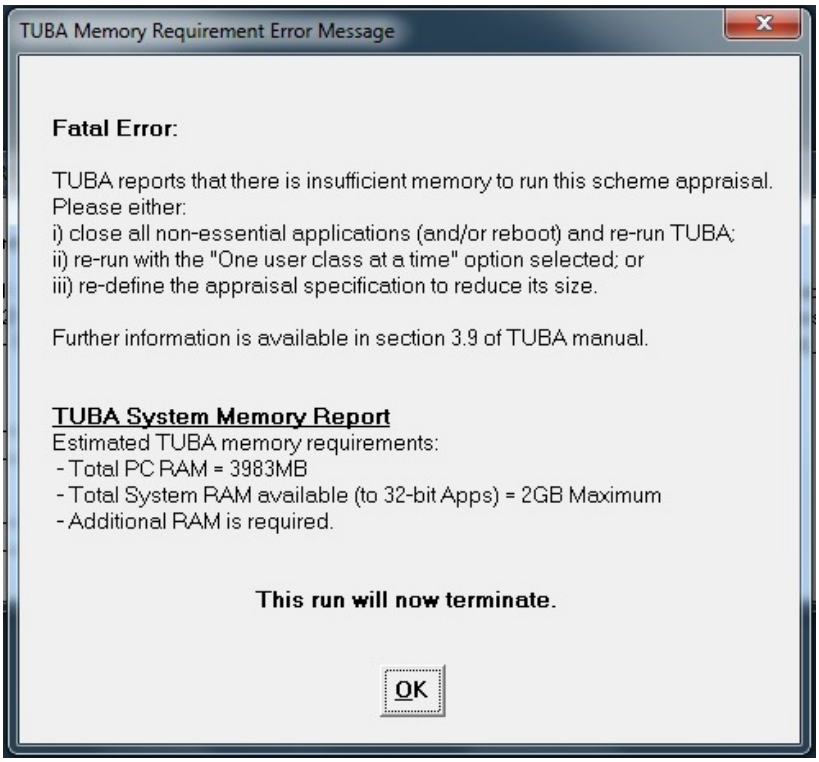
From TUBA v1.9.4 onwards, a new 64-bit version of TUBA was created alongside the existing 32-bit version for users running Windows 64-bit Operating Systems (OS). The Windows 64-bit OS enables suitably configured 64-bit programs to access more memory than 32-bit programs are able to – see section 3.11 below.

During the operation, all versions of the software may generate two types of error message as reproduced below:

(i) TUBA Memory Requirement Unavailable

Prior to running, TUBA will estimate the amount of memory required by pre-processing the Scheme file to determine the 'problem' size (i.e. in terms of zones, number of matrices, forecast years, time periods and user classes) and the memory 'reportedly available from the Windows Operating System. If insufficient memory is available, TUBA will terminate with a fatal error rather than attempting to continue and subsequently 'crash' with a dynamic memory allocation error (see Figure 3.5 below).

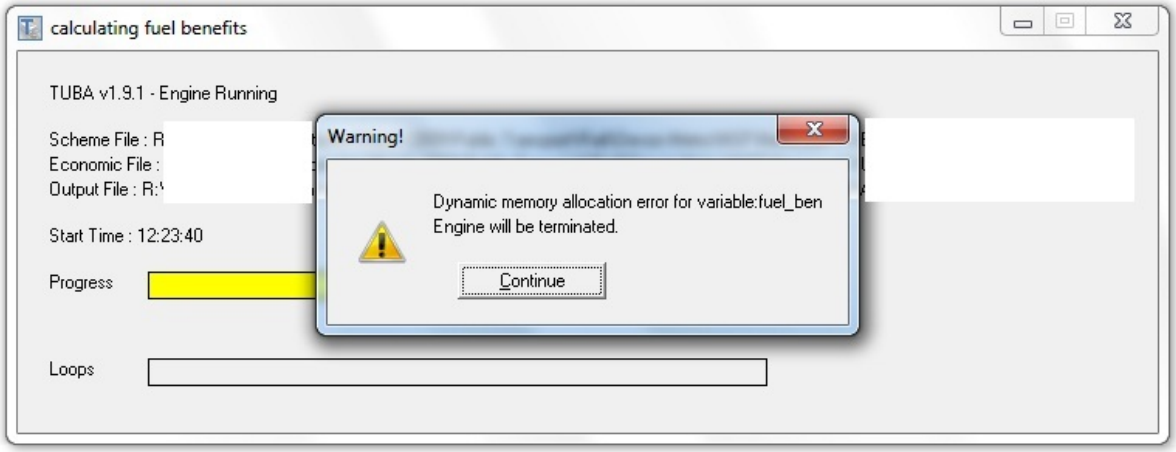
Figure 3.5: TUBA Memory Requirement Unavailable


TUBA Memory Requirement Error Message
Fatal Error:
TUBA reports that there is insufficient memory to run this scheme appraisal.
Please either:
i) close all non-essential applications (and/or reboot) and re-run TUBA;
ii) re-run with the "One user class at a time" option selected; or
iii) re-define the appraisal specification to reduce its size.
Further information is available in section 3.9 of TUBA manual.
TUBA System Memory Report
Estimated TUBA memory requirements:
- Total PC RAM = 3983MB
- Total System RAM available (to 32-bit Apps) = 2GB Maximum
- Additional RAM is required.
This run will now terminate.
OK

(ii) Dynamic Memory Allocation Error

The second error usually occurs towards the end of the TUBA run as the carbon calculations are undertaken when the Windows Operating System is unable to provide enough memory requested by TUBA (Figure 3.6). The initial checks (see above) will intercept the majority of these errors before running but the background Windows programs may have used the 'free' memory since the initial check was undertaken.

Figure 3.6: TUBA Dynamic Memory Allocation Error



3.9.2 Reducing Memory Problems

There are a number of ways in which memory issues can be alleviated depending on whether the 32-bit or (post v1.9.4 release) 64-bit version of TUBA is being used.

If the user is running a 64-bit version of the Windows Operating System, switching to the TUBA 64-bit version will significantly reduce the problems of insufficient memory – see section 3.11 below for more information.

If the TUBA 32-bit version is used (or in the unlikely event that memory problems occur with the 64-bit version), the options are available are:

- *Run one user class at a time* – in the Run -> Settings menu a tick box is provided to enable the processing of user classes to be performed one at a time. Selecting this will increase the size of model which TUBA is able to handle. For smaller models, deselecting this option reduces runtime.

  If this option is not selected, TUBA will assess its capacity to process the input provided and if sufficient memory is not available then the option to run one user class at a time will be suggested.

  NB: running "One User Class at a time" is the recommended option for all TUBA versions as it uses less memory but with comparable run times.

- *Free-up memory before running TUBA* - reboot the PC and close down all unnecessary applications (to increase the amount of free memory available) and re-run;
- *Detail of output* – Two options are provided in the Parameters menu of the scheme file:
  - *Detail* – setting this option to "Yes" enables the production of an additional output file with greater disaggregation of results. This file includes different types of user benefit and revenues for movements between all zones, providing a full OD matrix for each output, each disaggregated by time period, submode, purpose and person type. Setting this parameter to "No" disables this option, but also frees up memory for other processing;
  - *Zones_as_Sectors* – the additional output file mentioned above can be simplified by producing detailed results at a sectoral, rather than zonal, level. This involves grouping zones of similar location or land use into sectors (see section 5.7). Memory requirements can be reduced by setting zones_as_sectors to "No" and making use of a sector file. The fewer the number of sectors used, the lower the memory requirement will be.
- If none of the above options does not resolve a memory shortage, it may be possible to *separate the TUBA run into a number of smaller segments* and run each individually.

  A scheme file which includes a number of time slices can be adjusted such that each time slice is assessed using its own scheme file. In this instance each time slice will generate its own set of output files. Care should be taken in re-combining them, to ensure that benefits from all outputs are summed together, while costs are only captured once.

  Similarly a scheme file making use of intermediate points, using e.g. scenarios 0, a, b, c & 1, could be separated into four separate scheme files, using scenarios 0 & a in the first, a & b in the second, b & c in the third and c & 1 in the fourth.

  Note that a scheme file with a large number of modelled years cannot be separated in the same way.

If further advice is required, please contact TUBA technical support (tuba@atkinsglobal.com).

3.10 Reducing Run times

If a large number of runs are to be required for a detailed assessment, the processing time for TUBA can become considerable. If this is the case it may be worthwhile considering methods of reducing the program's run-time.

As TUBA currently constrains a given run to a single processor, when using a multi-core machine it may be beneficial in some cases to separate scheme files into different time slices, as set out in section 3.9 above. These can then be run at the same time and each run will make use of one processor simultaneously, rather than all elements being run sequentially.

In order to apply this technique, a separate economics file (each with identical content) will be required for each scheme file and separate batch files and sector files will be needed. Ideally separate matrices should also be used for each time slice, as the programme will abort if a file it tries to access is already in use.

Minimising the level of unneeded detail in calculations as set out in section 3.9 will also help to reduce run-times.

3.11 TUBA 32-bit and 64-bit Versions

With TUBA v1.9.4, significant improvements were made to the source code to enable the software to take advantage of the memory available under 64-bit Windows Operating Systems (OS). The software was migrated from Salford-FORTRAN to Intel Visual FORTRAN to enable it to:

- run on both 32-bit and 64-bit operating systems;
- enable it access more memory as a 64-bit application;
- use more efficient standard internal memory management routines; and
- run quicker (with model runtimes reduced by up to 30%).

There are now two standard versions of the TUBA software for use on 32-bit and 64-bit Windows OS - the TUBA 32-bit version will run on both Windows 32-bit and 64-bit systems whilst the TUBA 64-bit version will only run on the later.

Advantages of 64-bit

The advantage of the TUBA 64-bit is that the software is now able to access substantially more virtual memory, required for the appraisal of larger schemes, than available for the equivalent 32-bit version. The maximum amount of memory the 32-bit version is able to access is typically less than 2Gb (on either 32-bit or 64-bit OS) whereas the 64-bit version will only be constrained by the maximum the Windows OS is able to provide. For example, performance testing has shown that TUBA 64-bit was able to access around 100Gb of virtual memory. Therefore, the typical memory problems encountered by some users should now be avoided.

Which Version to use?

If users are running Windows 64-bit, we would recommend using the TUBA 64-bit version rather than TUBA 32-bit.

Which Version am I using?

Both versions share the same TUBA GUI (i.e. a 32-bit version of TUBA_G.EXE) with the differences in the TUBA calculation engine only (TUBA_ENG.EXE). The TUBA progress screen will show whether the 32-bit or 64-bit version is running and the resulting output file (.OUT) will also report on the version used.

Installed Location

By default, the 32-bit and 64-bit versions of the TUBA software will be installed in two different locations as follows:

TUBA 32-bit

- Install folder = "C:\Program Files\DfT\TUBA v1.9.4"
- Start menu = "DfT -> TUBA v1.9.4"

TUBA 64-bit

- Install folder = "C:\Program Files (x86)\DfT\TUBA v1.9.4 64-bit"
- Start menu = "DfT -> TUBA v1.9.4 64-bit"

Differences in TUBA Outputs

The outputs from the TUBA 32-bit and 64-bit will be very similar but not necessarily identical – there is a possibility that differences may arise from the internal numerical accuracy within the software. The differences will be scheme-dependent but are expected, based on practical testing, to be very very small (i.e. +/-1).

Backward Compatibility with .BIN Files

There are some minor detailed changes in TUBA Graphical User Interface (GUI) to enable the binary output files from the new TUBA engine to be read. Therefore, the binary files output files generated by TUBA v1.9.4 or later are not compatible with TUBA v.1.9.3 or earlier versions (and vice versa).

Windows Memory Limits

The maximum amount of memory that TUBA 64-bit is able to access is limited by:

- the specific 64-bit version of Windows used ranging from 8Gb for Windows 7 Home to 192Gb for Windows 7 Professional whilst Windows 8 ranges from 128Gb (Standard) to 512Gb (Professional). Further details may be found on the MSDN website[5]; and
- the maximum size of the Windows paging file that provides additional memory storage space – ideally it should be set to be system managed (if sufficient hard drive space is available)[6]

Acknowledgments

The original development work for TUBA 64-bit was funded by Transport for London in late 2013 with funding subsequently provided by the Department for Transport to enable its wider adoption.

[5] http://msdn.microsoft.com/en-us/library/windows/desktop/aa366778(v=vs.85).aspx

[6] http://windows.microsoft.com/en-gb/windows/change-virtual-memory-size

4. Economics data

4.1 General

The economics (and scheme) input file is an ASCII file consisting of a series of data tables. Each of these tables can be defined interactively via the user interface. Appendix A contains detailed data table formats for the economics file.

Certain features of data entry are common to several tables. These are explained in the following sub-sections.

4.1.1 Percentages

Where data is entered as percentages, for example growth rates, a value of, say, 20 is interpreted as 20%; 0.2 would be interpreted as 0.2% and not 20%.

4.1.2 Growth rates

Growth rates are required for a number of economic data. The common format is: start year, end year, rate (as % p.a.), e.g.:

Start year	End year	Rate
1999	2005	5
2006	2010	4

The interpretation of this is as follows: the 1999 value is 5% higher than the 1998 value, the 2000 value is 5% higher than the 1999 value and so on, up to the 2005 value being 5% higher than the 2004 value. Then 2006 is 4% higher than 2005 and so on. Where several periods with different growth rates are defined, they must not overlap.

Any growth defined after the appraisal horizon year will be ignored and a warning message issued.

4.2 Parameters

The following parameters are defined:

TUBA version	The current TUBA version. This is used to identify the format of the file and should not be edited
Base year	The base year for economic parameters. The standard value is 2010, meaning that VOT, value of fuel, etc. will be defined in 2010 prices and values. Outputs will be reported in base year prices.
Present value year	The year to which costs and benefits will be discounted
GDP in base year	The value of the Gross Domestic Product index in the economic base year. This is to allow scheme costs input in a different price base to be converted to base year prices.
Average indirect tax rate	The average rate of indirect taxation in the economy. This is used to convert from factor costs to market

	prices.
Base year untraded CO_2e values	The value, in pounds, of 1 tonne of untraded carbon dioxide equivalent emissions in base year prices; low, high and central values must be provided, in that order.
Base year traded CO_2e values	The value, in pounds, of 1 tonne of traded carbon dioxide equivalent emissions in base year prices; low, high and central values must be provided, in that order.

4.3 Category

The categories are

- Mode
- Vehicle type/submode
- Purpose
- Person type
- Fuel type

These categories serve two purposes. Firstly, the input and output data in TUBA can be disaggregated by category. Secondly, some of the economic parameters will vary by category; for example, value of time depends on person type, vehicle type and purpose.

4.3.1 Mode

Mode is the top level of aggregation in TUBA. It is primarily used for reporting purposes, although scheme costs are defined by mode. Results in the TEE table are disaggregated by mode.

Up to 5 modes may be defined. Each mode is given a name for reporting purposes.

4.3.2 Vehicle type/submode

Vehicle type/submode is a further disaggregation of mode. In TUBA separate trip and cost data have to be defined for each vehicle type/submode. Submode is a public transport equivalent of vehicle type. For example, in the standard settings 'rail' is a main mode with two submodes: 'light rail' and 'heavy rail'.

Up to 20 vehicle types/submodes can be defined. Each vehicle type/submode is allocated to a particular mode for reporting purposes.

Any new submodes or vehicle types are identified by entering 'Y' in the 'New submode?' column. A new submode is one that does not exist in the standard DM scenario, a typical example being the introduction of a new LRT line. For these submodes it is still necessary to define so-called pseudo-DM data. For further details of how to deal with new submodes in TUBA please see the user guidance document.

Park and ride submodes are identified with a 'Y' in the 'P&R?' column. This will affect the calculation of vehicle operating costs. Please see the user guidance document for more details on appraising park and ride schemes with TUBA.

Each vehicle type/submode must be identified as being used for personal travel ('per') or freight travel ('fre'). This is for reporting purposes only and does not affect the benefit calculations.

The following economic data will depend on vehicle type/submode:

- Value of time
- VOC coefficients
- Charge tax rates (i.e. taxes on fares, tolls, parking charges etc.)
- Non-fuel VOC tax rates
- Default purpose splits
- Default person type factors (i.e. vehicle occupancies)

4.3.3 Person type

The two person types currently defined in the standard economic parameters file are 'driver' and 'passenger'. A more disaggregate classification of person type can be used, for example to provide a more disaggregate application of values of time.

Up to 20 person types can be defined. Each person type must be identified as being either a driver (D) or a passenger (P) for public transport passengers. This is to aid conversion between vehicle and person trip matrices.

For data from a public transport model it is expected that all data will be for 'passenger' person type. Data from a highway model data is in 'vehicles' - in this case an 'all person' type is used and standard person type factors are used to calculate mean values of time per vehicle.

Help on dealing with bus drivers and passengers can be found in the TUBA guidance document.

The following economic data depend on person type:

- Value of time

4.3.4 Purpose

The disaggregation of data by purpose is important in TUBA because different formulae are used for business and consumer trips. If the transport model does not contain data disaggregated by purpose, standard purpose splits are defined in the economic parameters file and are applied to 'all purpose' data from the model.

Up to 10 purposes may be defined. In addition to being allocated a descriptive name each purpose must be identified as being business (B) purpose, consumer (C) purpose or other (O) purpose.

The following economic data depend on purpose:

- Value of time
- Default person type factors
- Non-fuel VOC coefficients

4.3.5 Fuel type

The current version of TUBA allows up to six fuel types to be defined.

The following economic data depend on fuel type:

- Fuel costs, including tax rates
- Fuel consumption coefficients
- Carbon dioxide equivalent emissions (emissions per unit of fuel and whether those emissions are "traded")
- Non-fuel vehicle operating cost coefficients

4.4 Time period

The standard economic file defines 5 standard periods:

- AM peak (0700-1000)
- PM peak (1600-1900)
- Inter-peak (1000-1600)
- Off-peak (1900-0700)
- Weekend (All hours)

Up to 10 time periods can be defined. In addition to a descriptive name for reporting purposes, additional comments can be made for each period.

Time periods are a broad categorisation for reporting purposes. It is recognised that certain models will have a more detailed representation of time; this is allowed for in the Time Slices section of the scheme file.

The following economic parameters depend on time period:

- Purpose split
- Person type factors (vehicle occupancies)

4.5 Breakpoints for reporting of benefits

The economics file specifies some breakpoints to allow benefits to be broken down by trip length and size of time saving. The format of the table is given in Appendix A.9.

The table has two rows specifying:

- Distance breakpoints (in kilometres) and

- Time saving breakpoints (in minutes).

4.6 Charges

Different types of charges can be defined. User charge benefits and operator revenues will be reported separately for each charge type. This allows the user to distinguish between, for example, the effects of inter-urban tolls, cordon charging, and car park charges.

As well as a description of each charge type it is necessary to use a three letter code to specify whether the revenues from the charge are received by the private sector ('pri'), central government ('cen') or local government ('loc').

4.7 Discount rate

This table defines the rate at which costs and benefits are discounted. Discount rates may vary over time. Each line of the table defines a period over which the discount rate is constant, along with the start and end years (inclusive) of the period. The start and end years are defined with reference to the current year (as defined in the scheme file), so that year '1' is the current year, year '2' is the current year plus 1 etc.

Discount rates between the present value year and the current year are assumed to be the same as in the current year.

4.8 Value of time

4.8.1 Base

The value of time (VOT) is used to convert time savings in, for example, minutes to monetary values. It depends on the submode, person type and trip purpose. These categories must have been set up before the user can enter VOT data.

VOT should be entered in pence per hour (p/hr) in perceived costs for business and consumer trips. Note that for business trips perceived costs will be the same as resource costs and are therefore not in market prices.

If VOT is not defined for a particular submode/person type combination it is assumed to be zero.

4.8.2 Growth

VOT growth is defined using the standard TUBA format (see Section 4.1.2). Different growth rates may be defined by purpose, but within each purpose the same rate applies to all submodes and person types.

4.9 Taxes

Taxes are used to convert between resource and perceived costs, to adjust values to market prices and to calculate government indirect tax revenues. The user is referred to the TUBA guidance document for an explanation of these terms.

The following tax rates are defined (together with growth rates for calculating future year tax rates):

- Fuel tax (duty and VAT)
- Tax on non-fuel VOC (final and intermediate consumption)
- Tax on user charges (final and intermediate consumption) (depends on charge type)
- Average rate of indirect taxation

In general the tax rate on intermediate consumption is that paid by business trips and includes duty, but not VAT. The final consumption rate is paid by consumer trips. For fuel, duty is paid by all trips but only non-fuel trips pay VAT.

The average rate of indirect taxation is used to convert business trip benefits and scheme costs to market prices.

4.9.1 Average indirect tax changes

This table defines the forecast growth rates for the average indirect tax rate using the standard TUBA format (see Section 4.1.2).

4.9.2 Base non-fuel VOC Tax Rates

This table defines the tax rates on non-fuel vehicle operating costs.

Rates must be defined for both intermediate and final consumption.

These tax rates depend on vehicle type/submode.

All tax rates are defined as percentages.

Vehicle types must have been defined before data can be entered in this table.

4.9.3 Growth in non-fuel VOC Tax Rates

This table defines growth rates for non-fuel VOC tax rates using the standard TUBA format (see Section 4.1.2. Growth rates depend on vehicle type/submode.

4.9.4 Base Charge Tax Rates

This table defines tax rates on user charges in the base year. Tax rates may differ by charge type.

Rates must be defined for both intermediate and final consumption.

Charge types must have been defined before data can be entered in this table.

4.9.5 Growth in Charge Tax Rates

This table defines the change in tax rates on user charges using the standard TUBA format (see section 4.1.2). Tax growth rates may differ by charge type.

4.10 Fuel

4.10.1 Cost

This table defines the following elements of cost for each fuel type for the base year:

- Resource cost (p/unit)
- Duty (p/unit)
- VAT (%)
- Carbon dioxide equivalent emissions (grammes per unit of fuel used)

4.10.2 Cost changes

This table defines the changes in the different cost elements (resource, duty and VAT) for each fuel type.

The last column of this table specifies percentage changes in CO_2e content of vehicle/fuel type combinations in order to reflect the impact of biofuels on CO_2e emissions.

4.10.3 Consumption

This table defines the *a*, *b*, *c* and *d* fuel consumption coefficients for each vehicle type and fuel type. These give fuel consumption in units per km (e.g. litres per km for petrol and kilowatt hours per km for electric) when applied to the following formula:

$$Fuel\ consumed = \frac{T}{D}\left(a + b\left(\frac{D}{T}\right) + c\left(\frac{D}{T}\right)^2 + d\left(\frac{D}{T}\right)^3\right)$$

where D and T are the distance in kilometres and the time in hours. The maximum value of D/T is restricted to the cut-off speed specified in the last column of the fuel consumption table for fuel consumption purposes.

For park and ride vehicle trips the fuel consumed per km is

$$Fuel\ consumed = \left(a + bV + cV^2 + dV^3\right)\Big/V$$

where V is the park and ride speed defined in the scheme file (see section 5.1).

If no vehicles exist for a particular fuel type/vehicle type combination then no coefficients need to be defined.

For certain submodes, e.g. rail, the VOC formula will not be applicable, in which case no parameters need be defined and no VOC benefits will be calculated. Operating costs for these modes will need to be obtained from other sources.

Note that VOC benefits will not be calculated for ‘passenger’ person types.

4.10.4 Efficiency

This table defines the increase in fuel efficiency by vehicle type and fuel type.

Increases in fuel efficiency correspond to a reduction in fuel consumption. A 10% increase in fuel efficiency is interpreted as a 10% reduction in fuel consumption for a given journey.

4.11 CO_2e value changes

This table defines how the cost of CO_2e emissions changes over time. Growth may be defined either as a rate in % per year, or in absolute terms in £ per year; it is not possible to define both for the same range of years.

From TUBA v1.9.2 onwards, different growth rates are applied to the low, central and high base year values whereas the same (central) growth rate was previously applied.

4.12 Fleet

4.12.1 Base

This table defines the base year fleet composition, that is, for each vehicle type, the proportion of vehicles of each fuel type. For each vehicle type the sum of the proportions across all fuel types should be 100%.

4.12.2 Changes

This table defines the changes in fleet composition over time. Changes should be specified for all fuel types.

To ensure that the fleet composition summed over all fuel types is 100% for each vehicle type, checks are performed on the total for each year. If the total in the base year is not within a tolerance of ±0.1% an error will be reported and the total must be corrected. For subsequent years, values will be rounded up pro rata for each fuel type so that the total is 100%.

Note that if the base year proportion of a particular fuel type is 80% and this decreases by 10% in the next year then the proportion in this second year will be 72% (not 70%).

4.13 Non-fuel VOC parameters

4.13.1 Base

This table defines the *a* and *b* resource non-fuel VOC coefficients by vehicle type and fuel type for business and consumer trips. These are used to calculate non-fuel VOC resource costs using the formula:

$$Non-fuel\ VOC = aD + bT$$

where D and T are the distance in kilometres and the time in hours.

For park and ride trips the formula is

$$Non-fuel\ VOC = aD + b\left(\frac{D}{V}\right)$$

where V is the park and ride speed defined in the scheme file (see section 5.1).

Different coefficients are used for business and consumer trips.

For certain submodes, e.g. rail, the VOC formula will not be applicable, in which case no parameters need be defined and no VOC benefits will be calculated. Operating costs for these modes will need to be obtained from other sources.

Note that VOC benefits will not be calculated for 'passenger' person types.

4.13.2 Changes

This table defines types of change in non-fuel VOC costs. The same rate is applied to all coefficients.

4.14 Purpose splits and person type factors

It is recognised that transport models are not always disaggregate enough to output results by trip purpose and that vehicle-based highway models may not contain data on occupancies. For this reason two types of default splits/factors are defined in the economics file. Where disaggregate model data are available they should always be used in preference to these defaults. Similarly, robust local data on purpose splits and occupancies should be used in preference to these national averages, by changing the values in the file.

4.14.1 Purpose splits

This table defines purpose splits by time period and submode. Splits should be entered as percentages. For each time period and submode the sum of splits across all purposes must be 100.

Purpose splits are used to disaggregate input trip and cost data that has not already been disaggregated by purpose. This is necessary because of the different formulae used to calculate business and consumer trip benefits.

4.14.2 Person factors (Vehicle occupancies): base

Person factors are a generalisation of vehicle occupancies. They depend on vehicle type, purpose and time period.

The person factors define the number of people of each person type for each submode/purpose combination, varying by time period. For example, if the person types are driver and passenger the driver person factor should always be 1. The passenger factor is the average number of passengers per vehicle.

Person factors can be summed over person types for a particular vehicle type/purpose/period combination to give occupancies.

When input trip and cost data are not disaggregated by person type the person factors are used to calculate mean VOTs per vehicle. Results are reported as 'all person types' and are not disaggregated by person type.

4.14.3 Person factors: changes

This table defines the change in person factors by time period for each submode/person type/purpose combination. A default growth rate of 0% is assumed.

4.15 Preparation and Supervision Costs

If the user does not explicitly define preparation or supervision costs in the scheme file then these can be calculated by TUBA. This table defines preparation and supervision costs, by mode, as a percentage of the total land and construction cost. Preparation costs depend on the current stage of preparation, which is one of the following:

- SI (Scheme Identification)
- PC (Public Consultation)
- PR (Preferred Route)
- OP (Order Publication)
- WC (Works Commitment)

For further details see the COBA manual (DMRB Volume 13): 13.1.2.7 – The Preparation of Cost Data for Use in COBA.

5. Scheme data

Like the economics file, the scheme file is an ASCII text file consisting of a series of data tables that can be edited interactively via the user interface. Detailed format specifications for these tables can be found in Appendix B.

5.1 Parameters

The following parameters are defined:

TUBA version	The current TUBA version. This is used to identify the format of the file and should not be edited.
Run name	A descriptive name for the TUBA run
Name of DM scenario	A descriptive name for the DM scenario
Name of DS scenario	A descriptive name for the DS scenario
First year	The first year of the appraisal period, i.e. the first year for which user benefits will be calculated
Horizon year	The last year of the appraisal period (normally First year +59 for a 60 year appraisal period)
Modelled years	A list of all the modelled years, separated by spaces. Up to 6 years may be defined. If the first year and horizon year are not the same at least 2 modelled years must be defined. Modelled years should lie between the first and horizon years (inclusive).
Current year	The year in which the TUBA run is being carried out. For automatic allocation of preparation costs this is the first year to which costs are allocated. It is also used to define 'year 1' for the discount rate table in the economics file.
Detailed results	Yes/No - whether a binary file containing fully disaggregate results should be output. This file can be interrogated via the user interface
No. of warnings to print	By default, this value is set to ‘All’ so that all serious warnings and error messages will be written to the outputs file. Setting this to a number will limit the number of warnings of each type that are output to that number.
P&R car speed	The average speed of the car leg of park and ride trips. This is used in the VOC calculations for P&R submodes instead of calculating speeds from the time and distance matrices.

Use zones as sectors	If 'Yes' then TUBA creates a sectoring system equivalent to one zone per sector. If 'No' then TUBA allocates all zones to a single sector. This does not affect the main .out output file, just the level of detail available in detailed results analysis. Note that setting 'Yes' is likely to significantly increase memory requirements and run time. This parameter has no effect for modes for which an explicit sector file has been defined.

5.2 Time slices

This table describes the time slices used in the model and how these correspond to the time periods defined in the economics file. The following data are required for each time slice:

- Duration of the time slice in minutes
- Annualisation factor
- Time period to which the time slice belongs
- Description

The annualisation factor is used to convert from benefits per time slice to annual benefits. The benefits in each time slice are multiplied by the annualisation factor and then summed to give annual benefits. The annualisation factor is therefore how many of this time slice there are in a whole year.

Advice on annualisation factors can be found in the separate TUBA guidance document.

5.3 Scheme Costs

The scheme costs entered should include all allowances for optimism bias as required by the Treasury Green Book. The appropriate adjustment factors for optimism bias at the different stages of a scheme should be obtained from the Overseeing Organisation. The definition of scheme costs is the same for both the do-minimum (DM) and the do-something (DS) and has 4 components:

- Scheme details
- Total costs
- Cost profile
- Delay costs

If costs for the DM or DS scheme are zero then no costs need to be defined.

5.3.1 Schemes

This table defines the following scheme data for each mode:

- The first year of construction

- The scheme opening year
- The scheme stage (SI, PC, PR, OP, or WC – see Section 4.15 for explanation)

These data are used primarily for the automatic calculation and allocation of preparation and supervision costs.

5.3.2 Costs

This table defines the total scheme costs. For each cost item the following are required:

- A one letter code for the type of cost: construction (C), land (L), operating (O), maintenance (M), grant/subsidy (G), preparation (P), supervision (S), developer and other contributions contribution (D)
- The mode to which the cost applies
- The sector which incurs the cost: private sector (pri), central government (cen) or local government (loc)
- The total cost in £000s
- Whether the cost entered is in factor costs (F) or market prices (M)
- The GDP for the year used to estimate the total cost

For grant/subsidy and developer contribution costs only sectors 'cen' and 'loc' are allowed. For grant/subsidy this defines who makes the payment – it is assumed that the private sector always receives the payment. For developer contribution the interpretation is slightly different – the sector defines who receives the payment and it is assumed the private sector always makes the payment. Grant/subsidy and developer contribution costs should be entered as positive numbers.

If preparation or supervision costs are not defined for a particular mode then 'default' can be entered in the total cost column (the last two columns can be left blank) and they will be calculated automatically as a proportion of land and construction costs. Preparation costs will depend on the current stage of the scheme. Percentages for the calculation of preparation and supervision costs are defined in the economics file.

All costs will normally be entered as positive numbers.

For construction costs, account must be taken of any change in the cost of road construction relative to the general price level. This used to be done in TUBA by using the Relative Price Factor (RPF). However, the current WebTAG Unit A-2 'Scheme Costs'[7] recommends the use of inflation rates relevant to the delivery of transport schemes. These should now be used in the preparation of base cost inputs for TUBA.

[7] https://www.gov.uk/government/publications/webtag-tag-unit-a1-2-scheme-costs-november-2014

Updated values for GDP can be found on the National Statistics web site at https://www.gov.uk/government/publications/webtag-tag-data-book-november-2014

5.3.3 Profile

For each mode this table defines the percentage of the total costs for each cost type that occur in each year. Normally for a given mode and cost type the percentages should sum to 100 across all years.

For cost types preparation, supervision, land and operating there is the option of using default profiles. If '-1' appears anywhere in the cost profile for a mode and cost type then the default profile will be applied. In each case the default profile is flat, with costs allocated equally to the appropriate years as follows:

- Preparation: current year to year before construction starts (inclusive)
- Supervision: first year of construction to opening year (inclusive)
- Land: all costs in first year of construction
- Operating: scheme opening year to appraisal horizon year (inclusive)

5.3.4 Delay

This table defines the cost of delays during construction and maintenance. The costs are specified by year and mode and split between business, commuting, other and freight travel. They should be entered in thousands of pounds in base year market prices.

5.4 Benefit change

In accordance with Section 2.4 of TAG Unit A-1[8] TUBA allows the user to define changes in the magnitude of benefits and revenues beyond the last modelled year. This is in addition to any change caused by economic factors, for instance growth in the value of time, and the standard extrapolation of benefits beyond the last modelled year (which is described in detail in the TUBA user guidance document).

This table is used to define rates of change in benefits beyond the last modelled year, by vehicle type/submode and time period. The standard TUBA conventions on defining growth rates apply. Changes should only be defined for the years from the last modelled year up to and including the horizon year.

5.5 User classes

Most assignment models operate with different user classes, each of which may have different generalised cost functions. For compatibility TUBA also has user classes, with each user class representing a particular combination of vehicle type (or submode), purpose and person type. The main function of user classes is to define what data each matrix contains. Up to 32 user classes can be defined.

[8] https://www.gov.uk/government/publications/webtag-tag-unit-a1-1-cost-benefit-analysis-november-2014

'0' can be entered for purpose, indicating 'all purposes', i.e. the data is not disaggregated by purpose. In this case the default purpose splits defined in the economics file are used to disaggregate the data.

'0' can be entered for person type, indicating that the data is not disaggregated by person type. This will most often be applied to data from a highway model where trip data is in vehicles. In this case, the default person splits (occupancies) are used to calculate the mean VOT per vehicle.

5.6 Matrices

For each user class and modelled year trip and travel time matrices must be defined. Distance matrices must also be defined for user classes for which VOC benefits need to be calculated. Charge matrices, representing for example fares, tolls and parking charges, are optional and need not be defined if there are no charges. The same file can be specified more than once, for example if the same distance matrix applies to a number of different user classes.

5.6.1 Table format

This table provides a list of all the trip and cost matrices to be read by TUBA. For each matrix the following are defined:

- the user class(es) to which the matrix applies
- the time slice(s) to which the matrix applies
- the type of data, indicated by a single letter code: vehicle trips (*V*), person trips (*P*), travel time (*T*), distance (*D*), or charge (C_n)[9]
- the matrix format: 1, 2 or 3 (see Appendix C)
- the scenario: 0 for DM, 1 for DS, a b c d or e for intermediate points
- the modelled year
- a factor for converting the data to the correct units (see below)
- the filename

Matrix data is expected in the following units:

Table 5.1: Matrix data expected units

Data	Units
Passenger or vehicle trips	Trips per hour
Distance	Kilometres
Time	Hours
Charge	Pence (perceived costs)

[9] 'n' is the charge type number, as defined in the economics file. For example, define the type as C3 for a charge type 3 matrix. 'C' will be interpreted as 'C1'

A factor can be defined to convert to the correct units. For example if a distance matrix is in metres then the appropriate factor to convert to kilometres is 0.001.

Details on matrix formats can be found in Appendix C.

Note that format 3 matrices can contain data for multiple user classes and time slices. In this case the user classes and time slices contained in the matrix are defined as in the following example:

1-3;5;7-8

which indicates that the matrix contains data for classes 1, 2, 3, 5, 7 and 8.

When the cursor is in the file name column of the data entry template the browse button on the toolbar can be used to select a matrix file.

5.6.2 Data checks

A number of checks are made on the consistency of the input matrices as follows:

- Trip matrices defined for both scenarios and for each modelled year
- Time matrix defined for each trip matrix
- Distance matrix defined for vehicle matrices
- Consistency in use of user classes between scenarios
- Maximum matrix cell values
- Ratio of DM to DS travel times and distances

The checks on the maximum values of matrix cells are as follows:

Table 5.2: Maximum value of data cells

Data	Maximum
Passenger or vehicle trips	100 000 trips/hr
Distance	1000 km
Time	10 hrs
Charge	50 000 pence

These checks are intended to identify possible errors in the units (e.g. minutes instead of hours) or anomalies in the source data.

The checks made on the ratio of DM to DS costs (time and distance) (r) are as follows:

Table 5.3: Data checks

Value of r	Action
r<A or r>D	Serious warning
A<r<B or C<r<D	Warning
B<r<C	OK, no warning

The values of A, B, C and D are:

Table 5.4: Limit values

A	B	C	D
0.33	0.67	1.5	3.0

These checks are made because in the case of large changes in cost the rule of a half which is used to calculate user benefits may not be valid.

With TUBA v1.9.1 onwards, the number of matrices that can be defined is (practically) limited to 4000; earlier versions were capped at 1500 but with higher limits available on request.

5.6.3 Intermediate points

Intermediate points are used when there are large cost changes between the DM and DS scenarios. For a detailed explanation of when they are needed and how to obtain suitable data please refer to the user guidance document.

Matrices for intermediate points are identified using scenarios *a*, *b*, *c*, *d*, and *e*. If there is just one intermediate point this must be scenario *a*. If there are two they must be scenarios *a* and *b* and so on.

When there is more than one intermediate point TUBA assumes that scenario *a* is the point closest to the DM, *b* the next closest and so on. This means that adding new intermediate points to a TUBA run already using intermediate points may require relabelling of the scenarios. TUBA will check that the values in the trip, time, distance and cost matrices are consistent with this ordering. For example, the number of trips in scenario a must be between the number of trips in the DM and the DS. Any intermediate points that do not follow this sequence will result in a warning and that intermediate point being ignored.

5.7 Sectors

Sectors are used to convert highway and public sector models, which may have different zoning systems, to a common base. They are also used to aggregate zones to simplify the analysis of the spatial distribution of benefits. The use of sectoring will reduce the memory requirements of the program and can significantly improve run times.

Sectoring has no impact on the total benefits, costs and revenues; it only affects the level of spatial detail available through the detailed results analysis option.

Each sector is an exact aggregation of one or more zones, i.e. sector boundaries cannot cut through a zone. The format of the sector definition file is given in Appendix D.

In this table the sector file for each mode is defined. The same file can be used for more than one mode. If no file is defined for a particular mode then the default sectoring method, as defined by the ‘use zones as sectors’ parameter in the scheme file PARAMETERS table, will be used.

The Browse button on the toolbar can be used to select sector files.

6. Output

6.1 Main output file (.OUT)

All runs of TUBA produce a standard text output file with the extension .OUT. This can be viewed via the View->Text Results menu option. The file contains various types of information as described in the following sections. Detailed table formats can be found in Appendix E.

The same data is also available in html format: View->Results->html. See Section 6.2 for more information on the html output files. Advantages of viewing the html files include a menu bar for navigating between tables and easier copying and pasting of tables to other applications.

Unless stated otherwise, monetary values are reported as perceived costs in thousands of pounds in base year market prices, discounted to the present value year.

A separate guidance document on checking TUBA results is supplied with the software or can be downloaded from the DfT TUBA website https://www.gov.uk/government/publications/tuba-downloads-and-user-manuals.

6.1.1 Input summary

A brief summary of key input information including run names, input file names, details of the appraisal period and a summary of the number of modelled hours.

6.1.2 Errors and warnings

A full list of warnings, serious warnings and errors. Warnings and serious warnings indicate possible anomalies in the input data and should be investigated. Errors will cause the TUBA calculation to stop and will need to be resolved in order for TUBA to run to completion.

Certain warnings and serious warnings relating to matrix data can occur many times for a given set of input data. These are grouped together, with matrix cells ranked in decreasing order of seriousness, identifying the user class, time slice, year and scenario and the matrix values (after the application of any matrix factor) in question. This applies to the following warnings:

Table 6.1: TUBA warnings and their causes

Warning	Likely cause
Ratio of DM to DS time or distance too high/low	Possible error in input data, otherwise large cost change which may invalidate rule of half
Matrix cell value too high	Error in input matrix, wrong units or incorrect matrix factor specified
Origin – destination speed too high/low	Error in input data (time/distance)
One of DM and DS (but not both) time or distance is zero	Attempting to use TUBA with a new mode. Contact technical support for advice.

For very large data sets it is possible to receive a '*Not enough memory*' error. To resolve this select the 'Run one user class at a time' option in the Run Settings template. If this fails to solve the problem then sectoring should be used with as few sectors as possible and if necessary allocating all zones to a single sector (see section 3.9 to 3.11 inclusive for further advice).

6.1.3 Economics file differences

The standard economics file is compared against the economics file in use for a TUBA run. The tables that differ between the two are output one after the other in the text output, and side by side in the HTML output.

Warnings are also reported of modifications to the growth in fleet composition input through the economics file.

6.1.4 Scheme costs

Three tables are used to report scheme costs. The tables DM_SCHEME_COSTS and DS_SCHEME_COSTS report undiscounted costs in base year market prices by mode, year and cost type. These tables can be used to check the automatic calculation of preparation and supervision costs and the use of default profiles.

The table PRESENT_VALUE_COSTS gives total investment and operating costs (i.e. excluding delays, grant or subsidy and developer contributions) by year and mode for the DM and DS schemes and reports the difference.

6.1.5 Trip matrix totals

The table TRIP_MATRIX_TOTALS reports the annualised trip totals by submode, time period and modelled year, for the do minimum and do something scenarios.

6.1.6 User costs

This table reports total user costs (time, charge, fuel and non-fuel VOC) for the DM and DS scenarios. Note that in a fixed trip matrix appraisal the user benefits will be the difference between DM and DS costs. This is not true in a variable trip matrix appraisal.

6.1.7 Fuel consumption

This table reports the total fuel consumption by fuel type and vehicle type for the DM and DS scenarios. The units are thousands of litres.

6.1.8 Carbon dioxide equivalent emissions

This table reports the total CO_2e emissions, in tonnes, for the DM, DS and the increase for each year and for each vehicle type. These figures are also presented monetised using the low, central and high values for CO_2e emissions. Two tables are produced, one for untraded CO_2e and the other for traded CO_2e.

N.B. The cost of any EU Allowances (EUAs) purchased to cover traded emissions (i.e. emissions from sectors covered by the EU Emissions Trading System) will be reflected in the purchase price of traded sector goods (such as electricity).

Since the purchase price is used in the costs considered in transport appraisal, the cost of the relevant EUAs will be included in the cost benefit analysis, 'internalising' the costs of emissions from traded sectors. The CO2 EMISSIONS BY TIME PERIOD TRADED reported in the table below are therefore provided for information purposes only - they are not included in the Economic Efficiency of the Transport System (TEE) table.

For further information, please refer to TAG Unit A-3 para. 4.1.4, 4.1.5 and 4.2.9.

6.1.9 CO_2e emissions by time period

This table gives a breakdown of CO_2e emissions and CO_2e benefits by time period for each of the modelled years and for the overall totals in the appraisal period. Two tables are produced, one for untraded CO_2e and the other for traded CO_2e.

6.1.10 User benefits and government and operator revenues

A series of tables reports user benefits (time, charge, fuel and non-fuel VOC), operator revenues and government indirect tax revenues, disaggregated by the various categories:

- Mode
- Submode
- Person type
- Purpose
- Time period

Note that the results by mode are given for each year of the appraisal period. For the other categories results are given for the modelled years and a total across all years.

6.1.11 Benefits by distance and by time saving

The TUBA output gives six tables that provide the breakdown of benefits by time saving and a breakdown by distance. These include:

- NON_MONETISED_TIME_BENEFITS_BY_TIME_SAVING
- MONETISED_TIME_BENEFITS_BY_TIME_SAVING
- TOTAL_BENEFITS_BY_TIME_SAVING
- NON_MONETISED_TIME_BENEFITS_BY_DISTANCE
- MONETISED_TIME_BENEFITS_BY_ DISTANCE
- TOTAL_BENEFITS_BY_DISTANCE

The information can be used to analyse whether benefits are concentrated on short-distance trips or long-distance trips; and whether the scheme benefits are made up of short time savings or longer time savings.

6.1.12 Sensitivity

The SENSITIVITY table reports the total user benefits as a percentage of the total DM user costs for each mode and modelled year. This is calculated using data in the DM&DS_USER_COSTS and MODE tables.

The information in this table can be used to assess the sensitivity of the user benefits calculated by TUBA to the level of convergence in the transport model; this is a requirement of the TAG advice (see section 6 of TAG Unit M-2 Variable Demand Modelling[10]). The smaller the numbers reported in this table, the more sensitive the results. TAG gives guidance on determining whether model convergence is adequate, given the size of the scheme benefits.

6.1.13 Transport Economics and Efficiency (TEE) Table

A summary of the results in TEE table format which is consistent with current TAG guidance.

6.1.14 Public Accounts table

A summary of the costs of the project to the public sector. This table is consistent with current TAG guidance.

6.1.15 Analysis of Monetised Costs and Benefits

A summary of all monetised costs and benefits assessed by TUBA. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented may not provide a good measure of value for money and should not be used as a basis for decisions.

For example, accident benefits will have to be added by the user.

This table is consistent with current TAG guidance.

6.2 HTML files

A total of four files are generated by TUBA for viewing the data in 'html' format. If the main output file is called *root.out* then the html files will be as follows:

root.html	The main html containing the frameset. Open this file in your internet browser to view the results. This file links to the following two files
root_menu.html	Contains the navigation menu. This file should not be opened directly; it is used by root.html
root_res.html	Contains all the TUBA results. This file can be opened on its own, but if you do so the navigation menu will not be available.

[10] https://www.gov.uk/government/publications/webtag-tag-unit-m2-variable-demand-modelling

root.xml	Unformatted TUBA results in xml format. This may be useful if you wish to develop your own applications to read TUBA results. Please contact TUBA support for more information (tuba@atkinsglobal.com).

If you wish to send html format results to someone else there are three options available:

- Only send *root_res.html*. The navigation menu will not be available.
- Send all three html files. The recipient should open root.html; the navigation menu will then be available
- While viewing *root.html* in your internet browser choose File-Save As and under File Type select Web Archive (*.mht). This single mht file can then be sent to the recipient. This may not work with all internet browser software.

6.3 .tbn file

A file with the extension .tbn is produced, with the same root file name as the main output file. This contains the time benefits for each mode and modelled year, cross-tabulated according to the change in trip numbers and travel time at OD cell level. The contents of this file can be used to decide whether it is necessary to run TUBA with intermediate points.

6.4 Export data option

If the scheme parameter 'Detailed results' is set to Yes then TUBA will output a binary file containing fully disaggregate results by year, submode, purpose, person type, period, origin and destination. This file can be interrogated using the Analysis->Export Data menu option (Figure 6.1).

Figure 6.1: Export data template

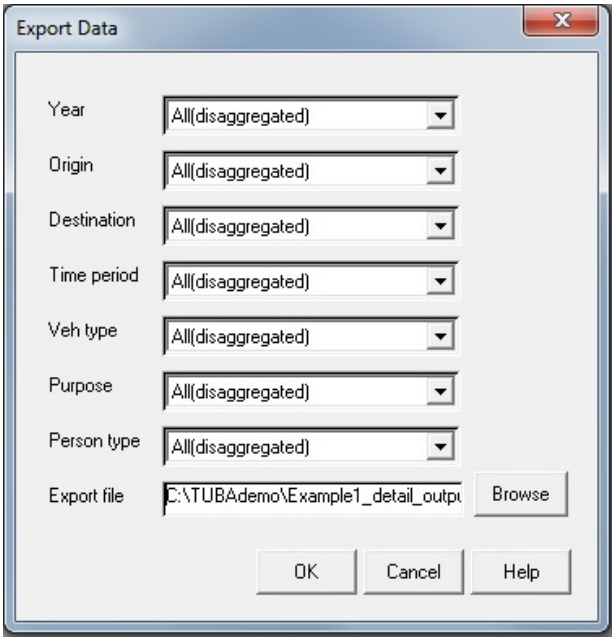


Figure 6.1 shows the export data template. A drop down box for each category is used to select a single value or 'All' data. An output file name must also be defined, using the Browse button if desired. The output file will be in CSV format for opening in a spreadsheet for further analysis or graphing.

TUBA:
User Manual
(Appendices)

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A. Economic parameters file

A.1 General

This Appendix contains the detailed file format specification for the economic parameters file. It is intended as a guide when editing the file directly, rather than via the user interface. The user is referred back to Section 4 for a fuller explanation of the data items.

The two input data files are structured in a similar way, consisting of a sequence of tables each of which contains a particular type of data. Tables are identified by a title in upper case which must match the table names given below, including underscores. All lines beginning with an asterisk '*' are treated as comments. All tables are in free format, i.e. there are no fixed field widths but all fields must be separated by at least one space.

A.2 Parameters

Table name: PARAMETERS

Field	Attribute	Data Type	Range / Description
1	Name	character	string
2	Value	(various)	integer, real, logical or character value
3	description	character	any string

The parameters currently recognised are:

The parameters currently recognised are:

TUBA version	The current TUBA version (e.g. 1.9.5)
base_year	The base year for which the parameters are defined, i.e. all reported values will be in base year prices
pres_val_year	The present value year; all costs and benefits will be discounted to this year
GDP_base	The index value of the Gross Domestic Product in the economic base year
av_ind_tax	The average rate of indirect taxation in the economy
nt_carbdxvalues	The value of one tonne of untraded CO_2e emissions; three figures are required, separated by a space, representing low, high and central valuations
t_carbdxvalues	The value of one tonne of traded CO_2e emissions; three figures are required, separated by a space, representing low, high and central valuations

A.3 Mode

Table name: MODE

Field	Attribute	Data Type	Range / Description
1	Mode number	integer	value in the range 1-5
2	Mode name	character	any string

Mode represents the highest level of aggregation for reporting purposes; in particular, results in the TEE table are displayed by mode. Scheme details and costs are also specified by mode.

A.4 Vehicle type /submode

Table name: VEHICLE_TYPE/SUBMODE

Field	Attribute	Data Type	Range / Description
1	vehicle type/submode number	integer	value in the range 1-10
2	Mode number	integer	value in the range 1-5
3	new submode?	character	Y or N
4	P&R?	character	Y or N
5	type (personal or freight)	character	per/fre
6	Name	character	any string

A.5 Person type

Table name: PERSON_TYPE

Field	Attribute	Data Type	Range / Description
1	person type number	integer	value in the range 1-20
2	Type	character	Driver or Passenger (D / P)
3	Name	character	any string

A.6 Purpose

Table name: PURPOSE

Field	Attribute	Data Type	Range / Description
1	purpose number	integer	value in the range 1-10
2	type (consumer or business or other)	character	C or B or O
3	Name	character	any string

A.7 Fuel type

Table name: FUEL_TYPE

Field	Attribute	Data Type	Range / Description
1	fuel type number	integer	value in the range 1-6
2	Fuel sector	integer	Values in the range 1-2 (1=untraded, 2=traded)
3	Name	character	any string

A.8 Time periods

Table name: TIME_PERIODS

Field	Attribute	Data Type	Range / Description
1	time period number	integer	value in the range 1-10
2	Name	character	any string

A.9 Benefit breakpoints table

The table has two rows.

Field	Data type and range	Description
1	String 'Distance' or 'TimeSaving'	Identifies whether this row contains breakpoints for Distance or Time Savings
2	Real >=0 for 'Distance'; any value for 'TimeSaving'	First breakpoint. Distance breakpoints in kms, Time saving breakpoints in minutes
3	"	Second breakpoint
4	"	…
5	…	…
6	Etc, up to 10 breakpoints	…

EXAMPLE:

* Breakpoints for breakdown of benefits by distance and time saving

- Distance 5 10 15 20 30
- TimeSaving -5 -2 0 2 5

The breakpoints are open ended. So, if the breakpoint values defined are a,b,c,d then the ranges they define are:

- <a
- ≥a, <b
- ≥b, <c

- ≥c, <d
- ≥d

Note that the lower end of the range is greater than or equals; the upper end strictly less than.

A.10 Charges

Table A.1 - Table name: CHARGES

Field	Attribute	Data Type	Range / Description
1	charge type number	integer	value in the range 1-10
2	sector	character	pri, cen or loc
3	Name	character	any string

A.11 Discount rate

Table name: DISCOUNT_RATE

Field	Attribute	Data Type	Range / Description
1	start year	integer	>0 (1 = current year)
2	end year	integer	>0, ≥start year
3	Rate	real	>0

A.12 Value of time

Table name: VALUE_OF_TIME

Field	Attribute	Data Type	Range / Description
1	vehicle type/submode	integer	value in the range 1-10
2	person type	integer	value in the range 1-20
3	VOT purpose 1	real	Perceived VOT (p/hr)
4	VOT purpose 2	real	
n+2	VOT purpose n	real	where n is up to 10

In this table values of time (VOTs) are defined by person type, purpose, and vehicle type/submode combination. The VOT for any such combination that is not explicitly defined is taken as zero.

VOTs are defined in pence per hour as perceived costs. Note that they should also be at factor cost for business purposes – TUBA will convert them to market prices.

A.13 Value of time growth

Table name: VALUE_OF_TIME_GROWTH

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	growth rate	real	growth in % for purpose 1, default=0
4	growth rate	real	growth in % for purpose 2, default=0
n+2	growth rate	real	growth in % for purpose n, default=0

A.14 Average indirect tax changes

Table name: AV_IND_TAX_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	Growth	real	% increases in average indirect tax rate (% pa),

A.15 Charge tax rates

Table name: CHARGE_TAX_RATES

Field	Attribute	Data Type	Range / Description
1	charge type	integer	value in the range 1-10
2	charge final	real	tax on charges final consumption
3	charge intermediate	real	tax on charges intermediate consumption

A.16 Charge tax rate changes

Table name: CHARGE_TAX_RATES_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	charge type	integer	value in the range 1-5
4	Final	real	% p.a. change
5	intermediate	real	% p.a. change

A.17 Fuel costs

Table A.2 - Table name: FUEL_COST

Field	Attribute	Data Type	Range / Description
1	fuel type	integer	value in the range 1-6
2	resource cost	real	resource value of fuel, pence per 'unit'
3	Duty	real	duty, pence per unit
4	VAT	real	Value Added Tax (%)
5	CO_2e emissions	real	CO_2e grams/unit used

A.18 Fuel cost changes

Table name: FUEL_COST_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	fuel type	integer	value in the range 1-6
4	resource	real	% change p.a. in resource value of fuel
5	duty	real	% change p.a. in duty
6	VAT	real	% change p.a. in VAT
7	CO_2e_density	real	% change p.a

A.19 CO_2e value changes

Table name: CARBDX_VALUE_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	non-traded cost change (rate) – Low	real	% change p.a. in value of non-traded CO_2e emissions (Low Growth Scenario)
4	non-traded cost change (absolute) – Low	real	absolute change £/p.a. in value of non-traded CO_2e emissions (Low Growth Scenario)
5	traded cost change (rate) – Low	real	% change p.a. in value of traded CO_2e emissions (Low Growth Scenario)
6	traded change (absolute) – Low	real	absolute change £/p.a. in value of traded CO_2e emissions (Low Growth Scenario)
7	non-traded cost change (rate) – High	real	% change p.a. in value of non-traded CO_2e emissions (High Growth Scenario)

Field	Attribute	Data Type	Range / Description
8	non-traded cost change (absolute) – High	real	absolute change £/p.a. in value of non-traded CO_2e emissions (High Growth Scenario)
9	traded cost change (rate) – High	real	% change p.a. in value of traded CO_2e emissions (High Growth Scenario)
10	traded change (absolute) – High	real	absolute change £/p.a. in value of traded CO_2e emissions (High Growth Scenario)
11	non-traded cost change (rate) – Central	real	% change p.a. in value of non-traded CO_2e emissions (Central Growth Scenario)
12	non-traded cost change (absolute) – Central	real	absolute change £/p.a. in value of non-traded CO_2e emissions (Central Growth Scenario)
13	traded cost change (rate) – Central	real	% change p.a. in value of traded CO_2e emissions (Central Growth Scenario)
14	traded change (absolute) – Central	real	absolute change £/p.a. in value of traded CO_2e emissions (Central Growth Scenario)

A.20 Fleet

Table name: FLEET

Field	Attribute	Data Type	Range / Description
1	vehicle type/submode	integer	value in the range 1-10
2	fuel type 1 split	real	% fuel type 1
3	fuel type 2 split	real	% fuel type 2
n+1	fuel type n split	real	% fuel type n

A.21 Fleet changes

Table name: FLEET_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	int	4 digit year (eg 2001)
2	end year	int	4 digit year (eg 2005)
3	vehicle type/submode	int	value in the range 1-10
4	fuel type 1 split change	real	% p.a. change
5	fuel type 2 split change	real	% p.a. change
n+3	fuel type n split change	real	% p.a. change

A.22 Fuel consumption

Table name: FUEL_CONSUMPTION

Field	Attribute	Data Type	Range / Description
1	vehicle type	integer	value in the range 1-10
2	fuel type	integer	value in the range 1-2
3	a - fuel consumption	real	fuel consumption coefficients
4	b - fuel consumption	real	
5	c - fuel consumption	real	
6	d-fuel consumption	real	
7	cut_off_speed	integer	3 digit (km/hr)

VOC parameters should only be defined for vehicle types/submodes that obtain their data from a highway model, such as cars or LGVs. If VOC parameters are not defined for a particular vehicle type/submode then VOC benefits are not calculated.

A, B, C, D FUEL CONSUMPTION COEFFICIENTS

These give the fuel consumed in litres per km using the formula:

$$Fuel\ consumed = \frac{T}{D}\left(a + b\left(\frac{D}{T}\right) + c\left(\frac{D}{T}\right)^2 + d\left(\frac{D}{T}\right)^3\right)$$

where D and T are the distance in kilometres and the time in hours. The maximum value of D/T is restricted to the cut-off speed specified in the last column of the fuel consumption table for fuel consumption purposes.

A.23 Efficiency

Table name: FUEL_EFFICIENCY

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	vehicle type	integer	value in the range 1-20
4	fuel type	integer	value in the range 1-6
5	eff	real	efficiency gains (%)

A.24 Non-fuel Vehicle Operating Costs

Table name: NON_FUEL_VOC

Field	Attribute	Data Type	Range / Description
1	vehicle type	integer	value in the range 1-10
2	fuel type	integer	values in the range 1-6
3	a - non-fuel VOC - business	real	non-fuel resource cost coefficients
4	b - non-fuel VOC - business	real	
5	a - non-fuel VOC - consumer	real	
6	b - non-fuel VOC - consumer	real	

A, B NON FUEL VOC COEFFICIENTS

These give the non-fuel VOC (in pence) when used in the formula:

$$Non-fuel\ VOC = aD + bT$$

where T is the travel time in hours and D is the distance in kilometres.

Different non-fuel VOC parameters are defined for business and consumer trips, reflecting the difference in vehicle fleet composition.

Non-fuel VOC parameters and the value of fuel should be input as resource values (i.e. exclusive of all taxes).

A.25 Non-fuel VOC changes

Table name: NON_FUEL_VOC_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	vehicle type	integer	value in the range 1-20
4	non-fuel	real	% change in non-fuel VOC coeffs

A.26 Non-fuel VOC tax rates

Table name: NON_FUEL_TAX_RATES

Field	Attribute	Data Type	Range / Description
1	vehicle type/submode	integer	value in the range 1-10
2	final	real	tax on non-fuel VOC final consumption
3	intermediate	real	tax on non-fuel VOC intermediate consumption

A.27 Non-fuel VOC tax rate changes

Table name: NON_FUEL_TAX_RATES_CHANGES

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	vehicle type/submode	integer	value in the range 1-10
4	Final	real	% p.a. increase
5	intermediate	real	% p.a. increase

A.28 Purpose split

Table name: DEFAULT_PURPOSE_SPLIT

Field	Attribute	Data Type	Range / Description
1	Vehicle type/submode	integer	value in the range 1-10
2	purpose	integer	value in the range 1-10
3	period 1 split	real	split value (%) in period 1
4	period 2 split	real	split value in period 2
n+2	period n split	real	split value in period n

Purpose splits **must** add up to 100 when summed over each vehicle type/submode and time period combination.

A.29 Person factors

Table name: DEFAULT_PERSON_FACTORS

Field	Attribute	Data Type	Range / Description
1	vehicle type/submode	integer	value in the range 1-10
2	purpose	integer	value in the range 1-10
3	person type	real	value in the range 1-20
4	period 1	real	person type factor in period 1
5	period 2	real	person type factor in period 2
n+3	period n	real	person type factor in period n

Default person factors are an extension of occupancy factors, but recognise that a more detail categorisation than driver/passenger may be required. Occupancies can be deduced by summing the factors over all person types for a particular vehicle type/submode, purpose and time period.

If the user is unable to input matrices by person type then these factors are used to calculate mean VOTs for each vehicle type/submode, purpose and time period combination.

A.30 Change in Person factors

Table name: DEFAULT_PERSON_FACTORS_CHANGE

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2001)
2	end year	integer	4 digit year (eg 2005)
3	vehicle type	integer	value in the range 1-10
4	Purpose	integer	value in the range 1-10
5	person type	real	value in the range 1-20
6	period 1	real	% change in person type factor, period 1
7	period 2	real	
n+5	period n	real	% change in person type factor, period n

A.31 Preparation & Supervision Costs

Table name: PREPARATION&SUPERVISION

Field	Attribute	Data Type	Range / Description
1	Mode	integer	1-5
2	prep: SI	real	Prep costs, stage SI, % of land and construction costs for this mode
3	prep: PC	real	
4	prep: PR	real	
5	prep: OP	real	
6	prep: WC	real	
7	superv	real	Supervision costs, % of land and construction costs for this mode

B. Scheme-specific file

B.1 Parameters

Table name: PARAMETERS

Field	Attribute	Data Type	Range / Description
1	Name	character	string
2	Value	(various)	integer, real, logical or character value
3	description	character	any string

The parameters currently recognised are:

TUBA version	The current TUBA version (e.g. 1.9.5).
Run_name	A descriptive title for this TUBA run.
do_min_name	A descriptive title for the do-minimum scheme.
do_som_name	A descriptive title for the do-something scheme.
First_yr	The first year for which user benefits can be calculated.
horizon_ yr	The last year for which user benefits should be calculated (usually 60 years after the opening year).
modelled_ yrs	The years for which trip and cost matrices will be defined (between first_yr and horizon_yr). If the opening year and horizon year are the same then there can be only one modelled year. Otherwise there must be at least two modelled years (a maximum of 6 is allowed).
detail	If 'yes' then the detailed results file is output. If 'no' the detailed results file is suppressed
Current_yr	The first year for which scheme costs are incurred.
print_warn	Whether to print all warning messages ('All') or limit the number of each warning type (in which case the parameter value should be set to the desired maximum).
p&r_car_speed	The average speed of the car leg of park and ride trips. Used in the calculation of vehicle operating costs for park and ride trips.
zones_as_sectors	If 'yes' then TUBA assumes a one to one correspondence between zones and sectors.. If 'no' then all zones are allocated to one sector. This parameter has no effect on the sectoring system for modes for which a scheme file has been explicitly defined.

B.2 Time slices

Table name: TIME_SLICES

Field	Attribute	Data Type	Range / Description
1	time slice	integer	value in the range 1-32
2	duration (mins)	real	length of time slice
3	annualisation factor	real	how many of this time slice in a whole year
4	time period	integer	value in the range 1-10
5	description	character	

B.3 Schemes (DM and DS)

Table name: SCHEMES_DM, SCHEMES_DS

Field	Attribute	Data Type	Range / Description
1	mode	integer	value in the range 1-5
2	first construction year	integer	first year of construction for scheme for this mode
3	opening year	integer	4 digit year - opening year for scheme for this mode
4	stage	character	current preparation stage for this mode: SI, PC, PR, OP or WC

B.4 Costs (DM and DS)

Table name: DO_MIN_COSTS, DO_SOM_COSTS

Field	Attribute	Data Type	Range / Description
1	type	character	C, L, M, O, S, P, G or D: construction, land, maintenance, operating, supervision, preparation, grant/subsidy or developer or other contribution
2	mode	integer	value in the range 1-5
3	sector	character	pri/cen/loc (private sector, central govt, local govt)
4	cost	Real/ character	total cost (£1000s), or 'default' for TUBA to calculate (P & S costs only)
5	price	character	M (market prices) or F (factor cost)
6	GDP	real	GDP in year for which costs are estimated

B.5 Profile (DM and DS)

Table name: DO_MIN_PROFILE, DO_SOM_PROFILE

Field	Attribute	Data Type	Range / Description
1	year	integer	4 digit year (eg 2000)
2	mode	integer	value in the range 1-5
3	% construction	real	% of total construction cost for this mode that is spent in this year
4	% land	real	
5	% prep	real	
6	% super	real	
7	% maintenance	real	
8	% operating	real	
9	% grant/subsidy	real	
10	% developer or other contribution	real	

-1 can be entered as the % for land, preparation, supervision or operating costs to indicate that the default profile should be used.

B.6 Delay costs (DM and DS)

Table name: DO_MIN_DELAY_COSTS, DO_SOM_DELAY_COSTS

Field	Attribute	Data Type	Range / Description
1	year	integer	4 digit year (eg 2000)
2	mode	integer	value in the range 1-5
3	construction and maintenance delays - business	real	value of delay costs during construction and maintenance (£1000s base year market prices)
4	construction and maintenance delays – commuting	real	"
5	construction and maintenance delays - other	real	"
6	construction and maintenance delays - freight	real	"

B.7 Benefit changes

Table name: BENEFIT_CHANGE

Field	Attribute	Data Type	Range / Description
1	start year	integer	4 digit year (eg 2021), after last modelled year
2	end year	integer	4 digit year (eg 2069), up to 60 years after 'first year'
3	vehicle type	integer	value in the range 1-10
4	Benefit growth, time period 1, %pa	real	
3+n	Benefit growth, time period n, %pa	real	

B.8 User classes

Table name: USER_CLASSES

Field	Attribute	Data Type	Range / Description
1	class number	integer	value in range 1-32
2	vehicle type/submode	integer	value in range 1-10
3	purpose	integer	value in range 1-10
4	person type	integer	value in range 1-20

Purpose and person type can be zero, representing 'all purposes' and 'all person types' respectively.

B.9 Input matrices

Table name: INPUT_MATRICES

Field	Attribute	Data Type	Range / Description
1	matrix number	integer	value in the range 1-4000
2	user class number	-	single value (formats 1,2) or range for format 3 matrices
3	time slices	-	single value or range for format 3 matrices
4	Type	char	Highway veh trips (V)*, public transport passenger trips (P)*, time (T), charge (Cn) or distance (D)
5	Format	integer	1,2,3
6	Scenario	integer	0=do-min, 1=do-som, a b c d or e for intermediate points
7	Year	integer	4 digit year (eg 2016)
8	Factor	real	factor to convert to standard units (default=1.0)
9	Filename	char	

*Note: * highway trips **must** be specified in **vehicles** and public transport passenger trips in persons.*

B.10 Sectors

Table name: SECTORS

Field	Attribute	Data Type	Range / Description
1	mode number	integer	value in the range 1-5
2	sector file name	character	name of sector file name for this mode

C. Matrix formats

Three different formats are available in TUBA. They are designed to be compatible with the most widely-used transport modelling packages.

C.1 TUBA Format 1

Row	Field	Attribute	Data Type	Range / Description
n	m	value for origin n, destination m	real	non-negative; CSV format

Example:
0,20,15
25,0,15
20,30,0
(3 x 3 matrix with zero intra-zonal trips)

This is a 'square' matrix format, with values defined for all origin-destination pairs.

C.2 TUBA Format 2

Field	Attribute	Data Type	Range / Description
1	origin	integer	
2	destination	integer	
3	Value	real	non-negative, CSV format

Example:
100,101,20
101,100,15
(value of 20 from zone 100 to zone 101, and 15 from zone 101 to zone 100)

Note that data only needs to be defined for origin-destination pairs with non-zero values.

C.3 TUBA Format 3

Field	Attribute	Data Type	Range / Description
1	Origin	integer	
2	Destination	integer	
3	user class	integer	
4	value in first time slice	real	non-negative
5	value in second time slice	real	non-negative
n+3	value in nth time slice	real	non-negative

Example:
100 101 1 20 15 25
101 100 1 30 25 20

(data for user class 1 for three time slices)

Formats 1 and 2 are comma separated variable formats. Format 3 is 'free' format, i.e. there must be a space between fields.

In format 1 origin and destination numbers are not defined explicitly and are allocated to a sequential numbering system. Also in format 1 data must be defined for every single OD pair. In formats 2 and 3 only data for OD pairs with non-zero trip numbers needs to be defined.

D. Sector file format

Field	Attribute	Data Type	Range / Description
1	zone number	integer	zone number
2	sector number	integer	sector to which this zone belongs

The sector definition file consists of two columns. The first identifies the zone number and the second defines the sector to which it belongs. Sectors must be defined for all zones.

In the following example zones 1 and 2 belong to sector 1 and zones 3 and 4 belong to sector 2:

```
1  1
2  1
3  2
4  2
```

E. Output file (*.out)

Like the input files the output file is divided into a series of tables. Unless stated otherwise, all costs and benefits are reported as perceived costs and market prices in thousands of pounds. Monetary values are discounted to the present value year unless otherwise stated.

E.1 Input summary

This table contains a summary of key input data.

E.2 Economics File Comparison summary

This section summarises the differences between the standard economics file and the economics file used in the appraisal. If the standard economics file has been used this section is empty.

E.3 Errors and warnings

This is a full list of errors, warnings and serious warnings encountered during the calculations. Errors cause the program to stop and therefore their cause must be rectified. The program will carry on after a warning or serious warning; it is the responsibility of the user to check that they are not caused by errors in the input data.

E.4 DM and DS scheme costs

Field	Attribute	Data Type	Range / Description
1	mode	string	
2	year	integer	
3	prep	real	preparation costs
4	super	real	supervision costs
5	constr	real	construction costs
6	land	real	land costs
7	maint	real	maintenance costs
8	oper	real	operating costs
9	grant/sub	real	grant/subsidy costs

These tables give undiscounted scheme costs in base year market prices. Their main use is in checking the application of default calculations for preparation and supervision costs and in the use of default profiles.

E.5 Present value costs

Field	Attribute	Data Type	Range / Description
1	mode	string	
2	year	integer	All cost years and total
3	DM scheme costs	integer	£, discounted to PVY
4	DS scheme costs	integer	
5	Difference	integer	DS-DM scheme costs

This is a tabulation of the scheme costs in base year prices discounted to the present value year. It contains investment and operating costs only (i.e. it excludes the grant/subsidy and delays that were defined in the scheme costs table).

E.6 Trip matrix totals

Field	Attribute	Data Type	Range / Description
1	submode	string	
2	year	integer	modelled years only
3	time period	string	
4	do-min trip totals	integer	annualised trip totals
5	do-some trip totals	integer	

This table reports annualised trip numbers, using the same units as the input matrices (i.e. vehicle trips or person trips).

E.7 DM and DS user costs

Field	Attribute	Data Type	Range / Description
1	mode	integer	
2	year	integer	Modelled years only
3	do-min : user time	integer	
4	do-min : user charges	integer	split by charge type
5	do-min : fuel VOC	integer	
6	do-min : non fuel VOC	integer	
7	do-som : user time	integer	
8	do-som : user charges	integer	
9	do-som : fuel VOC	integer	
10	do-som : non fuel VOC	integer	

This is a tabulation of total user costs in the DM and DS scenarios. For example, the DM total time is the value of the total travel time in the DM scenario.

In a fixed trip matrix appraisal the user benefits will be the DM cost minus the DS cost. This will not be the case with a variable trip matrix.

E.8 Fuel consumption

Field	Attribute	Data Type	Range / Description
1	vehicle type	integer	
2	year	integer	Modelled years and all years total only
3	do-min : fuel type 1	integer	total fuel consumption, thousands of litres
4	do-min : fuel type 2	integer	
5	do-som : fuel type 1	integer	
6	do-som : fuel type 2	integer	

Total fuel consumption by vehicle type, fuel type and scenario (DM and DS). These are not monetary units and are therefore not discounted.

E.9 CO_2e emissions (traded and non-traded separately)

Field	Attribute	Data Type	Range / Description
1	vehicle type	integer	
2	year	integer	Year or All for total over all years
3	DM tonnes	integer	DM emissions, 1000s of tonnes
4	DS tonnes	integer	DS emissions, 1000s of tonnes
5	DS-DM tonnes	integer	Increase in emissions, 1000s of tonnes
6	DM value (low)	integer	Value of DM emissions (low)
7	DS value (low)	integer	Value of DS emissions (low)
8	DS-DM value (low)	integer	Increase in value (DS-DM) (low)
9	DM value (central)	integer	Value of DM emissions (central)
10	DS value (central)	integer	Value of DS emissions (central)
11	DS-DM value (central)	integer	Increase in value (DS-DM) (central)
12	DM value (high)	integer	Value of DM emissions (high)
13	DS value (high)	integer	Value of DS emissions (high)
14	DS-DM value (high)	integer	Increase in value (DS-DM) (high)

E.10 CO_2e emissions by time period (non-traded and traded separately)

This table gives a breakdown of CO_2e emissions and CO_2e benefits by time period for each of the modelled years and for the overall totals. The table below gives an example of the format for an appraisal with AM, IP and PM time periods; and 2010, 2025 as modelled years:

		Emissions (tonnes)			Cost (£000s,low)			Cost (£000s,med'm)			Cost (£000s,high)		
Period	Year	DM	DS	Increase	DM	DS	Increase	DM	DS	Increase	DM	DS	Increase
AM peak	2010												
AM peak	2025												
PM peak	2010												
PM peak	2025												
Inter-peak	2010												
Inter-peak	2025												
AM peak	Total												
PM peak	Total												
Inter-peak	Total												

N.B. The cost of any EU Allowances (EUAs) purchased to cover traded emissions (i.e. emissions from sectors covered by the EU Emissions Trading System) will be reflected in the purchase price of traded sector goods (such as electricity).

Since the purchase price is used in the costs considered in transport appraisal, the cost of the relevant EUAs will be included in the cost benefit analysis, 'internalising' the costs of emissions from traded sectors. The CO2 EMISSIONS BY TIME PERIOD TRADED reported in the table below are therefore provided for **information purposes only** - they are not included in the Economic Efficiency of the Transport System (TEE) table.

For further information, please refer to TAG Unit A-3 para. 4.1.4, 4.1.5 and 4.2.9.

E.11 Mode

Field	Attribute	Data Type	Range / Description
1	mode	integer	
2	year	integer	All years and total
3	benefits : user time	integer	
4	benefits : user charges	integer	split by charge type
5	benefits : fuel VOC	integer	
6	benefits : non fuel VOC	integer	
7	benefits : operator revenues	integer	split by charge type
8	benefits : indirect taxes	integer	

User benefits, operator revenues and indirect taxes by mode and year for all years from the scheme opening year to the horizon year.

E.12 Submode

Field	Attribute	Data Type	Range / Description
1	veh type/ submode	integer	
2	year	integer	Modelled years and all years total only
3	benefits : user time	integer	
4	benefits : user charges	integer	split by charge type
5	benefits : fuel VOC	integer	
6	benefits : non fuel VOC	integer	
7	benefits : operator revenues	integer	split by charge type
8	benefits : indirect taxes	integer	

User benefits, operator revenues and indirect taxes by vehicle type/submode and year for all modelled years.

E.13 Person types

Field	Attribute	Data Type	Range / Description
1	person type	integer	
2	year	integer	Modelled years and all years total only
3	benefits : user time	integer	
4	benefits : user charges	integer	split by charge type
5	benefits : fuel VOC	integer	
6	benefits : non fuel VOC	integer	
7	benefits : operator revenues	integer	split by charge type
8	benefits : indirect taxes	integer	

User benefits, operator revenues and indirect taxes by person type and year for all modelled years.

E.14 Purpose

Field	Attribute	Data Type	Range / Description
1	purpose	integer	
2	year	integer	Modelled years and all years total only
3	benefits : user time	integer	
4	benefits : user charges	integer	split by charge type
5	benefits : fuel VOC	integer	
6	benefits : non fuel VOC	integer	
7	benefits : operator revenues	integer	split by charge type
8	benefits : indirect taxes	integer	

User benefits, operator revenues and indirect taxes by purpose and year for all modelled years.

E.15 Period

Field	Attribute	Data Type	Range / Description
1	period	integer	
2	year	integer	Modelled years and all years total only
3	benefits : user time	integer	
4	benefits : user charges	integer	split by charge type
5	benefits : fuel VOC	integer	
6	benefits : non fuel VOC	integer	
7	benefits : operator revenues	integer	split by charge type
8	benefits : indirect taxes	integer	

User benefits, operator revenues and indirect taxes by period and year for all modelled years.

E.16 Benefits broken down by time saving and distance

There are six output tables with the same format - three giving the breakdown of benefits by time saving, three for the breakdown by distance:

- NON_MONETISED_TIME_BENEFITS_BY_TIME_SAVING
- MONETISED_TIME_BENEFITS_BY_TIME_SAVING
- TOTAL_BENEFITS_BY_TIME_SAVING
- NON_MONETISED_TIME_BENEFITS_BY_DISTANCE
- MONETISED_TIME_BENEFITS_BY_ DISTANCE
- TOTAL_BENEFITS_BY_DISTANCE

An example format is given below.

NON_MONETISED_TIME_BENEFITS_BY_TIME_SAVING Time benefits (thousands of person hrs) by size of time saving								
Vehicle type /submode	**Purpose**	**Year**	**<-5 mins**	**-5 to -2 mins**	**-2 to 0 mins**	**0 to 2 mins**	**2 to 5 mins**	**>5 mins**
Car	Business	2010						
Car	Business	2025						
Car	Business	Total						
Car	Commute	2010						
Car	Commute	2025						
Car	Commute	Total						
…								
Rail	Other	2010						
Rail	Other	2025						
…								

E.17 Sensitivity

Field	Attribute	Data Type	Range / Description
1	mode	string	
2	sensitivity	real	user benefits divided by DM user costs
n+1	"	"	n is number of modelled years

User benefits, by mode and modelled year, as a percentage of total DM user costs.

E.18 Economy: Economic Efficiency of the Transport System (TEE Table)

A summary of the benefits (transport users and private sector providers) in TEE table format, giving the present value of benefits (PVB) of the scheme.

E.18.1 Public Accounts Table

A summary of the costs of the project to the public sector, giving the present value of costs (PVC) of the scheme.

E.18.2 Analysis of Monetised Costs and Benefits

A summary of all monetised costs and benefits assessed by TUBA. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented may not provide a good measure of value for money and should not be used as a basis for decisions.

For example, accident benefits will have to be added by the user.

F. Partitioned time benefits file (*.tbn)

This file contains the time benefits for each mode and modelled year cross-tabulated according to the change in travel time and trip numbers at OD level. It is used to assess the impact of large cost changes on total benefits and to decide whether it is necessary to use intermediate points.

Field	Attribute	Data Type	Range / Description
1	range of change in trip numbers	char	e.g. 10%-20%
2	time benefits for first range of time changes	integer	Discounted £000s.
N+1	time benefits for Nth range of time changes	integer	